Chapter 9
Physical Rehabilitation Programmes Following ICU Discharge

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What Is the Problem?

Earlier chapters in this book, as well as a significant body of literature, have clearly outlined the cognitive, physical and mental health implications of post-intensive care syndrome and the associated disability and societal consequences for patients, their carers and families and the broader community.

An argument can be made that there is significant face validity in providing physical rehabilitation to optimize recovery for survivors of critical illness. It is untenable for patients to remain indefinitely bed-ridden, without the provision of services to assist them in their recovery of an ability to sit unsupported, stand and walk to a level sufficient for them to provide self-care and achieve their activities required for daily living in an independent manner (or at least to return to their baseline activities). In much the same way basic nursing care (i.e. assistance with turning in bed, feeding, toileting and medication administration) is not up for debate as to whether it is beneficial or not – like a parachute – it is simply required [1].

Following ICU discharge, management is frequently multidisciplinary with the aim of achieving functional independence to enable discharge into the community.

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Following discharge, rehabilitation can be home- or centre-based or via telehealth and generally aims to improve muscle strength, functional independence and cardiovascular endurance [2].

However, the question follows: what level of service provision of physical rehabilitation following ICU discharge is sufficient to achieve patient goals? And what are these goals? To extend life span regardless of quality? To return to a baseline level of functional independence sufficient to return home? Or to return to the patient baseline function, whatever that may have been? Or perhaps to return the patient to an even higher functional level than that before their ICU admission – not an unlikely occurrence or unreasonable goal in the event of chronic declining health that culminates in an event or intervention that reverses such health decline (e.g. insertion of a cardiac stent, organ transplant or other successful surgical procedures). Any health service intervention such as physical rehabilitation, most frequently provided by physiotherapists in the hospital and community settings [3], must be subject to rigorous evaluation in order to optimise the spending of health dollars to maximise outcome for as many as possible.

Moreover, it must be asked: how can such services be best provided to optimise equity in access, treatment and outcomes? Disadvantaged populations (i.e. non-white, poor educational level) do even worse following critical illness [4–6]; therefore, incumbent upon our health service delivery is an ethical obligation to ensure we optimise the outcomes of all.

Proven Solutions: Review of Evidence Base

Why Post-ICU Rehabilitation Programmes?

While an earlier chapter in this book focuses on early mobilisation commencing in the ICU, the largest proportion of physical rehabilitation following critical illness takes place in the acute wards, in other inpatient facilities (as appropriate) and in the community following discharge home.

These programmes are therefore critical to evaluate, especially since once sufficient functional restoration has been achieved to enable such discharge back into the community, there is a relative stable state from which changes in outcomes are potentially more easily quantified.

However, despite the perception of benefit in physical rehabilitation programmes following ICU discharge, the studies conducted in the area to date (Table 9.1) deliver two important conclusions:

1. Post-ICU physical rehabilitation programmes (as studied to date) do not work.
2. More targeted research is required to define where such services should be delivered.

Table 9.1 Selected studies investigating post-ICU physical rehabilitation programmes, in order of design (SR/MA) and then sample size, chronologically

Author	Design	Sample size[a]	Intervention	Control	Primary outcome measures	Summary
Taito et al., 2019 [37]	SR MA	10 trials (1110 participants)	Commenced earlier/more intensive physical rehabilitation than control	Control	HR-QOL (PCS, MCS), mortality	Intervention-level physical rehabilitation following ICU discharge does not affect HR-QOL or mortality in MV patients
Connolly et al., 2015 [2]	SR	6 trials (483 participants)	Intervention commenced after ICU discharge	Any other intervention/ control or usual care	Functional exercise capacity HR-QOL	Unable to determine an overall effect on functional exercise capacity or health-related quality of life of interventions initiated after ICU discharge for survivors of critical illness
Morris et al., 2016 [8]	RCT	300 participants	Daily physical therapy until hospital discharge	Weekday physical therapy if ordered by clinical team	Hospital LOS	No difference in primary outcome
Cuthbertson et al., 2009 [11]	RCT	286 participants	Rehabilitation package/ manual, for 3 months after discharge	No intervention	Mortality, HR-QOL Cost-effectiveness	No difference in primary or secondary outcomes at 12 month follow-up; follow-up programmes more costly so unlikely to be cost-effective
Walsh et al., 2015 [38]	RCT	240 participants	Mobilisation in hospital from ICU discharge until hospital discharge (max 3 months)	Usual care	RMI, HR-QOL	Post-ICU hospital-based rehabilitation did not improve physical recovery or HR-QOL but improved patient satisfaction
Elliott et al., 2011 [39]	RCT	195 participants	Home-based physical rehabilitation programme for 8 weeks, five times weekly	Usual care	6MWT Physical function	Intervention did not change physical function recovery (similar in both groups)
Denehy et al., 2013 [7]	RCT	150 participants	Physical rehabilitation in ICU, in acute wards (daily) and post-hospital discharge for 8 weeks (x3 weekly)	Usual care	6MWT, HR-QOL	No differences in primary outcome, rate of change over time/mean between group differences in 6MWT greater in intervention group

(continued)

Table 9.1 (continued)

Author	Design	Sample size[a]	Intervention	Control	Primary outcome measures	Summary
Jones et al., 2003 [12]	RCT	126 participants	Rehabilitation package/ manual for 6 weeks, daily	No intervention	Mortality, HR-QOL, depression, anxiety, phobic symptoms, PTSD	Intervention group reported an improvement in physical function (as measured by SF-36 HR-QOL scores) at 8 weeks and 6 months
Moss et al., 2016 [40]	RCT	120 participants	ICU, hospital floor/ward, home-based/outpatient Physical therapy programme: breathing, exercises, functional mobility, range of motion Provided for 28 days, daily in hospital and 3 days/ week when discharged home (outpatient or home-based)	For 28 days or until hospital discharge participated in a physical therapy programme (exercises, functional mobility)	Physical function performance (CS-PFP-10)	An intensive physical therapy program did not improve physical function performance at 1, 3 or 6 months
McDowell et al., 2017 [41]	RCT	60 participants	Personalised exercise programme for 6 weeks, three times weekly	No intervention	Self-reported physical function (SF-36 PF domain)	No statistically significant difference in the primary outcome measure of self-reported physical function
McWilliams et al., 2016 [42]	RCT	63 participants	Outpatient exercise and education programme for 7 weeks, three times weekly	No intervention	Mortality, HR-QOL Exercise capacity	Outpatient rehabilitation improved health-related quality of life but not exercise capacity
Batterham et al., 2014 [43]	RCT	59 participants	Physiotherapist-led, hospital-based exercise for 8 weeks, two times weekly	No intervention	HR-QOL, anaerobic threshold	Small benefit in intervention group compared to control for the anaerobic threshold of 1.8 (95% confidence interval, 0.4–3.2) ml O2/kg/min, not sustained by week 26. No significant differences in HR-QOL

[a]Studies had to include a minimum of 50 participants for inclusion in the table. *RCT* randomised controlled trial, *ICU* intensive care unit, *HR-QOL* health-related quality of life, *MV* mechanical ventilation, *PCS* physical (health) component summary score (of the Short Form-36), *MCS* mental (health) component summary score (of the Short Form-36), *PF* physical function, *LOS* length of stay, *RMI* Rivermead Mobility Index, *6MWT* 6-minute walk test, *PTSD* post-traumatic stress disorder, *SF-36* Short Form-36, *CS-PFP-10* Continuous Scale Physical Functional Performance 10

Why Don't These Programmes Work?

Many hypotheses have been advanced as to the lack of benefit quantified to date in the randomized trials conducted, including heterogeneity in study groups, if not in diagnoses, in clinical trajectory (as outlined below in the tiered framework) and arbitrary definition of inclusion terms for studies rather than inclusion based on need; high mortality & attrition from programs/loss to follow up; provision of rehabilitation to patients who would not benefit (either too well, or too sick); sub-optimal outcome measure selection and insufficient dosing of rehabilitation and lack of separation between groups. In several of the bigger studies, the differences between intervention and control were i) minimal and ii) at doses likely insufficient to achieve cardiovascular or musculoskeletal training benefit based on exercise physiology principles. For example, Morris and colleagues, the intervention group received a median 5 days of physical therapy and 3 days of resisted exercise compared with a median 1 day in the control group; while Wright and colleagues reported the delivery of a median (IQR) of 23 (16–28) minutes for 10 (4–19) days in the intervention group and 13 (10–17) minutes for 6 (2–12) days in the usual care group (7–10). It is also possible that these programmes are just not beneficial in this population when applied to the whole population and that individualised rehabilitation solutions are required, depending on need, access and response.

It could also be hypothesised that rehabilitation programmes reported in the literature to date have predominantly concentrated on the physical aspects of recovery [2] and have not incorporated cognitive and psychological interventions nor addressed remedial issues of social disadvantage that potentially have a greater impact on outcomes such as health-related quality of life. Where this has been attempted [11, 12], interventions have been in a passive format (i.e. rehabilitation manuals) where measuring adherence to intervention is more difficult.

Speculative Solutions: What Does Best Practice Look Like?

The extent to which these post-ICU deficits are reversible remains arguable – are survivors destined to be left with loss of physical function? Can this loss be mitigated with physical rehabilitation? Are fat mass gains reversible? Can this loss be fully reversed with physical rehabilitation? To what extent should adaptation be a focus of rehabilitation programmes rather than futile attempts at restoration of muscle mass/strength and function?

Characteristics identified from observational and trials of rehabilitation such as comorbidity [13, 14] and APACHE 2 scores [15], age [16, 17] and sex [16] have been identified as important in recovery and can potentially be used to identify cohorts of patients who may benefit from rehabilitation. Comorbidity and premorbid health-related quality of life have long been associated with outcomes following critical illness [18–22]. Alternatively, it is appealing to consider how rehabilitation

is delivered and stratify this by clinical phenotypes, and an early paper by Elliott and colleagues [23] described a three-tiered framework which aimed to assist in this process from the beginning of an ICU admission as follows:

- Tier 1 patients: defined as a brief, uncomplicated ICU care trajectory with low risk of physical impairment, likely ventilated for <48 hours
- Tier 2 patients: ventilated for 48 h but less than 7 days, with a steady improvement trajectory in ICU over 3–4 days and a moderate risk of physical impairment
- Tier 3 patients: complex ± long-stay trajectory in ICU, with prolonged ventilation and a high risk of significant physical impairment and disability

Combined with stratifying phenotypes according to physical function (i.e. patients able to stand, vs. non-standing patients) as a clinically meaningful way of tailoring rehabilitation and outcome measurement efforts [23], this framework identified groups broadly similar to Herridge and colleagues [17] and aims to consider the varying needs of presenting patients following critical illness, regardless of diagnosis, which can lead to significant heterogeneity in study groups.

While there have been additional efforts to describe trajectories of recovery, the earliest attempts at this were conceptual, largely not based on empirical data, and also did not include conceptualisation of trajectories where patients returned to their baseline level or even superseded it [24]. Recent work, based on empirical data, must be given more emphasis and demonstrates clear differences in trajectories, such as patients who either fully recovery completely or not (resulting still in a third unclassifiable group) [25] or who suffer disability and either (i) do not improve by 6 months, (ii) have minimal initial improvement and residual disability at 6 months, (iii) have initial low function who improve by 6 months or (iv) have intermediate function and rapid improvement by 6 months [16, 26]. Unfortunately, such work is limited by a lack of comparison with baseline physical function, and while studies have attempted to address this post hoc [27], urgent work is required to facilitate clear and accurate measurement of baseline physical function in ICU patients (proxy-validated) to establish trajectories across the arc of care following admission, especially since factors such as disadvantage and chronic comorbidity (associated with health status) predict poor outcomes [4, 5].

A further limitation in evaluating such 'recovery trajectories' is that most studies interrogating such trajectories are limited to the sickest patient populations (i.e. ARDS, septic shock), which do not always represent the majority of cases journeying through an ICU in any given time period. Excluding less sick cases from evaluation skews the data such that it looks like ICU survivors have poor recovery outcomes, whereas studies with more generalisable inclusion criteria (i.e. LOS in ICU > 48 hours) have found different results that may suggest many patients admitted to the ICU return to their baseline level of function/quality of life without additional rehabilitation [27].

Perhaps it is only cost-effective to return patients to a level of independence fit for return to their home-living situation rather than return to usual level of function. These outcomes, or the stated goals once defined, should be distinguished; the

former is certainly used as a criterion for discharge from acute care and rehabilitation facilities all over the world – once a patient can walk and perform their usual ADLs, they can return home, but is this the same as their baseline level of function? In many cases, no. Few post-ICU rehabilitation programmes have aimed to define the clear end-goal and whether it was achieved – variously reporting the quality of life or walking distance 'improvements'; however, these lack meaning in a clinical context. Does it matter to Bill Smith if he can walk on average 50 m more in 6 minutes following rehabilitation, or if his VO_2 peak improves by 1 mL/kg/min, if he can walk to the post office like he did before, or he can't run marathons like he did before? These studies and results, along with previously described outcome measures [23], are devoid of context and urgently need rethinking if they are to be patient-centred in their conduct, application and ability to inform clinical care delivery.

It is clear from the current evidence base that these questions remain to be answered, and work is in progress which will continue to progress and inform our understanding of these issues [28]. Most follow-up ICU studies, including those of post-ICU rehabilitation programmes, are significantly limited by attrition and loss to follow-up, including high mortality rates (at least 50% of ICU admissions in one Australian long-term follow-up study were dead by 5 years) [29]. It is clear that old models of physical attendance to a centre for outpatient rehabilitation, especially in the era of COVID19 [30], do not work, are not financially viable and are no longer sustainable. Tele-rehabilitation [31, 32], remote models of care and independent exercise programmes [33] leveraging portable wearable/fitness technology [34] and the most disadvantaged groups [6] must be the way of the future. Stratification of inclusion also needs to target those most likely to benefit, as there is clear evidence that not all ICU survivors are equal [14, 16, 25–27] and, indeed, may not need additional rehabilitation. Moreover, in terms of improving access and reducing costs of service delivery, rehabilitation of critical care patients must begin to be streamlined into existing services to leverage current infrastructure. There are many existing outpatient disease-specific rehabilitation programmes for patients with chronic diseases, into which the majority of ICU survivors fall, and there have been efforts to combine such programmes into multimorbidity rehabilitation programmes providing exercise training for any patient with clinical need rather than providing care in siloes [35, 36]. This streamlined model of offering individualised exercise prescription (where exercise training principles are the same, regardless of diagnosis(es)) in group or virtual training settings mitigates the need to run costly siloed disease- or setting-specific programmes in parallel and would markedly improve cost-effectiveness as well as access across the healthcare system.

There is an urgent need to design studies tailored to the considerations outlined above and investigate their outcomes in the context of patient-centred, clinically meaningful goals, as well as their feasibility, success in behavioural adherence and cost-effectiveness. We recommend that funds that would be channelled into delivering standalone post-ICU rehabilitation services with little evidence of benefit would be better invested into conducting empirical research to inform future health service delivery.

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